

Around the Laboratories

A glimpse of what could happen at 40 TeV – collision energies which could be reached in the proposed US Superconducting Super Collider (SSC). This shows the probability (at 40 TeV) of seeing at least z times the average number of secondary charged particles according to the old (KNO) picture, and the prediction based on the new distribution measured by the UA5 experiment at the CERN Collider. The probabilities for seeing larger numbers of secondaries increase by several orders of magnitude.

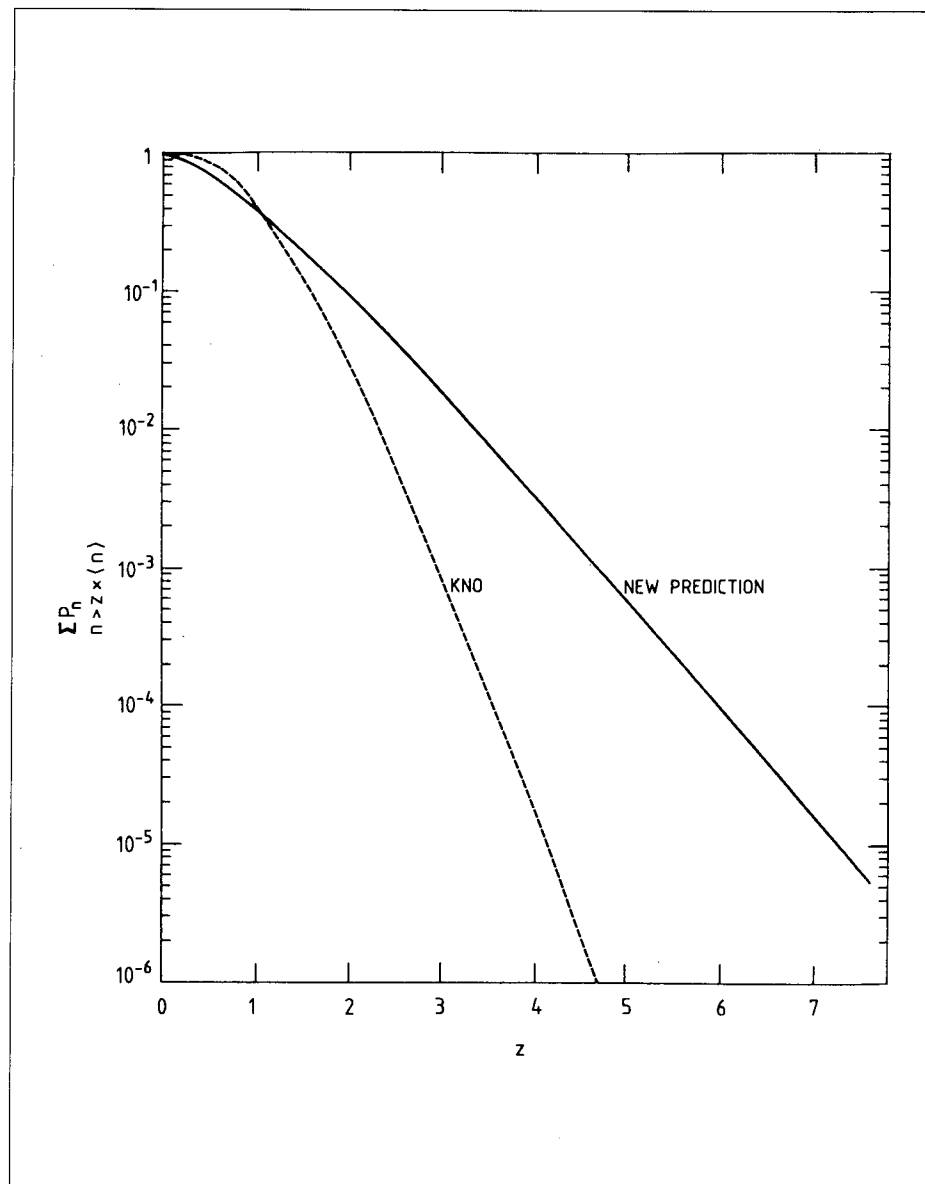
CERN Scale model

One of the major initial objectives of the experiments at CERN's unique proton-antiproton Collider at the SPS was to survey the general behaviour of particle interactions in the new energy range opened up by having particle beams of hundreds of GeV crashing head-on into each other, and to see if it corresponded to what is seen at lower energies.

In the late 1960s, experiments were searching for the deep inner structure of the proton. If an incoming beam could penetrate deep enough inside a proton and interact with hard constituent grains ('partons'), then the description of the observed behaviour could be simplified to depend only on kinematical variables and on the distribution of the partons inside the nucleons. With these 'scaling' ideas, once behaviour under one set of conditions had been observed, then what happens elsewhere could be predicted by rescaling according to the kinematics.

At the big Stanford linac, 20 GeV electron-proton scattering experiments showed this behaviour, demonstrating for the first time that the deep interior of the proton was being probed.

Extensions of this scaling idea were formulated, and in 1972 Z. Koba, H. B. Nielsen and P. Olesen predicted that the number of charged particles produced (multiplicity) in high energy hadron collisions should follow a simple rule – the so-called KNO scaling. Surveys of particle multiplicities at the highest hadron energies available showed that KNO scaling seemed to fit.



However in the meantime further experiments using a variety of particle beams showed that the original scaling as seen at Stanford was only approximate. This was no surprise, as after all the arguments supporting scaling were only a first approximation to the complexities of nucleon constituent scattering. The subtle 'scaling violations' seen in these subsequent experiments gave useful

clues to what happens deep inside nucleons.

In 1981, the CERN proton-antiproton Collider came into operation and opened up a new energy horizon. The first experiment to take data was the UA5 collaboration (Bonn/Brussels/Cambridge/CERN/Stockholm) using two 7.5 metre streamer chambers above and below the interaction region to record the tracks emerging from

At CERN, work for the new LEP electron-positron collider pushes steadily forward. On 26 July, the first tunnelling machine broke through into the vertical shaft at Point 2 after having started its journey at Point 1, thus completing one-eighth of the 27-kilometre tunnel. Meanwhile (below) the first electron gun to provide LEP's particles has been installed in the new injector building.

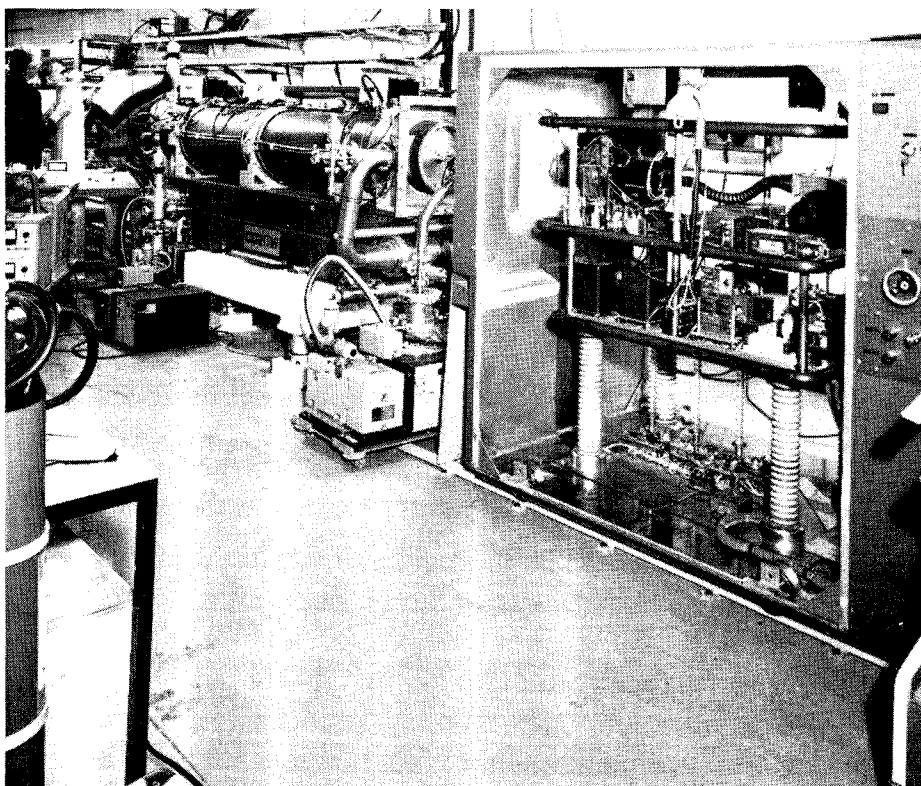
(Photos CERN 471.7.85 and 60.5.85)

the collisions, initially at a total energy of 540 GeV. In 1984 this collision energy was increased to 630 GeV, and in a run earlier this year to 900 GeV (see May issue, page 131). Charged particle multiplicities of a hundred or more are efficiently recorded.

The UA5 team finds particle multiplicities to be well described by a two-parameter (negative binomial) distribution, resembling that used for counting photons (generalized Bose-Einstein statistics). One parameter is the average multiplicity (which obviously varies with energy), while the second comes from statistical mechanics and is a measure of the number of independent quantum states available. This distribution covers the full energy range, from fixed target experiments right up to the 900 GeV collision energies recorded earlier this year.

The second parameter of the multiplicity distribution varies with energy in a very simple and unexpected way – depending inversely on the logarithm of the energy. KNO scaling on the other hand would require this parameter to be constant. Looking back at the empirical multiplicity distributions measured in the collision energy range from about 10 to 60 GeV, the approximate scaling which showed up is now seen to be fortuitous rather than reflecting some aspect of particle behaviour.

The new distribution suggests that at higher energies, still wider ranges of multiplicities can be expected. These are already being seen by UA5 in the 900 GeV data from the CERN Collider, and would lead to striking effects at the 20 TeV Superconducting Super Collider (SSC) being proposed in the US.



MEDDLE in business

The four big experiments currently being prepared for CERN's new LEP electron-positron collider have to face up to the technology explosion in the areas of data handling and communications.

Because of their sheer size, the dimensions of LEP itself (a ring 27 km in circumference) and the highly international makeup of the participating teams, these experiments encounter special problems, which are moreover not alleviated by increasing manpower and financial restrictions.

To coordinate the computing and related requirements for LEP experiments, a CERN committee has been set up, named 'MEDDLE' after a highly contrived acronym. It is comprised of two people from each of the four LEP experiments, plus the leaders of the support groups involved at CERN, and other interested parties, including Ian Butterworth, CERN Director responsible for both LEP experiments and for the Laboratory's computing, and Data Handling Division Leader Paolo Zanella, who is chairman of the committee.

In his introduction, Ian Butterworth said that one major function of MEDDLE will be information exchange, with the experiments presenting their needs for computing and related services, and the support groups presenting the workplans that they feel they can sustain given the money and manpower constraints. However, he hopes that MEDDLE will also be powerful and representative enough to set priorities and allocate resources, especially in the area of setting up collaborative projects. He emphasised that in the present situation of limited

budgets and manpower, the choices facing MEDDLE may be rather brutal.

The new committee has no shortage of business to discuss, and no less than 27 topics having been brought up by at least one LEP experiment. A series of whole day meetings have been scheduled to deal with groups of related topics such as networks; general topics and support for computers, workstations and terminals; off-line; online, etc. Other topics, including compiler problems and the cost of cooled Fastbus electronics, have been deemed urgent.

To coordinate European inter-Laboratory computing, a Computing Coordination Committee, with members from major European national Laboratories and research centres, was set up last year (see April 1984 issue, page 102).

DESY The birth of H1 and ZEUS

Two formal letters of intent for experiments at the HERA proton-electron collider were aired in an all-day meeting at the Germany DESY Laboratory in Hamburg on 11 July. The new collaborations, H1 and ZEUS, include about 400 physicists from 65 institutes in 11 countries. The experiments should be ready to take data at the beginning of 1990, – but installation will of course start much earlier.

Recommendations on these letters of intent are expected to be made by the DESY Physics Research Committee (PRC) before the end of the year. After technical clarifications, a decision will be taken by the middle of next year.

The 'letters' are in fact rather detailed papers, each about 90 pages, including a lot of preliminary information on the ideas of the two groups. It is certainly premature to go into the details of these two devices. As initially presented, both include a superconducting solenoid, providing a longitudinal magnetic field for transverse momentum measurements in a central jet-type tracking device. Both detectors include big electromagnetic and hadronic calorimeters, as well as muon chambers, covering most of the solid angle. They both have an iron toroid for muons in the forward direction. However the two designs are quite different, reflecting the technological background of the collaborating groups. H1 uses a liquid argon calorimeter while ZEUS prefers scintillator readout.

The DESY meeting showed the remarkable international interest in the HERA project. In addition to 120 physicists from West Germany, the collaborations include 54 from the United Kingdom, 48 from the US, 25 each from Canada and France, 21 from Poland, 10 from the Netherlands, 5 from Israel, 4 from Switzerland, 2 from Spain, and no less than 82 from Italy.

While Italy has been involved from the beginning in the construction of HERA and now continues for the experiments, the level of British participation is also worth noting. The investment required for each of the two new detectors will amount to about 100 million DM, the major part of which will have to come from outside Germany.

Meanwhile the first section of the HERA tunnel has been cut (see photo on next page).